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<p>(54) Title: METHOD FOR CONDUCTING HANDOFF BACK COMMUNICATION SCENARIOS</p>		
<p>(57) Abstract</p> <p>A method supporting Mobile Station (MS) handoff back operations across tandem switches makes use of a modification of the ANSI-  (41) Standard. The method, which may be adapted to networks supporting path minimization operations, determines that a handoff back  call connection operation to a Target Mobile Switching Center (Target MSC) (65) should occur, verifies that a designated channel (107) of  the Target MSC (65), which may be an Anchor MSC (AMSC) (65) or Tandem MSC is available to support the MS (50), establishes a third  inter-MSC trunk (185) between the Serving MSC (95) (SMCS) and the Target MSC (65), moves the MS (50) to the designated channel  (107), and directs a Tandem MSC (75), and the SMSC (95) to release unused inter-MSC trunks.</p>		

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METHOD FOR CONDUCTING  
HANDOFF BACK COMMUNICATION SCENARIOS

CROSS REFERENCE TO RELATED APPLICATIONS

5 This application claims the benefit of U.S.  
Provisional Application No. 60/133,992, filed on May  
13, 1999, which is incorporated herein by reference in  
its entirety.

BACKGROUND OF THE INVENTION

Technical Field

10 This invention relates generally to mobile  
cellular telecommunications, and more particularly, to  
a method of utilizing existing signaling protocols,  
such as the American National Standards Institute  
(ANSI)-41 protocol, to implement more efficient handoff  
15 back operations.

History of Related Art

Within a telecommunications network that supports  
Mobile Station (MS) roaming, several methods have been  
devised to transfer communications for active call  
20 connections maintained by any one MS as it moves away  
from one serving switch toward another. The American  
National Standards Institute (ANSI)-41 D Standard  
includes several procedures and messages to implement  
such inter-system (inter-exchange) handoff forward  
25 operations (i.e., transferring the active call  
connection of a MS from the serving switch to a target  
switch which is not currently trunk-connected in the  
call), and handoff back operations (i.e., transferring  
the active call connection from the serving switch to  
30 a target switch which is already trunk-connected within  
the call path). While several scenarios are offered  
for handling handoff forward operations with a tandem  
switch, only two scenarios are available when a handoff

back operation must be accomplished. Further, the handoff back call connection operation is only valid for use when the target switch is connected directly to the serving switch (i.e., there is a direct trunk connection therebetween). Thus, for example, the handoff back message cannot be used to transfer a call connection from a serving Mobile Switching Center (MSC) to an anchor MSC using the anchor MSC as the target switch if there is a tandem MSC located along the call path between the anchor MSC and the serving MSC.

While it is possible to invoke the handoff back operation under such circumstances (i.e., where multiple switches are trunk-connected along a call path, and the target switch is not immediately trunk-connectable to the serving switch), the result will be that trunks between the various switches (connected before handoff) will not be released after the handoff operation occurs. Thus, network resources are wasted.

Another problem occurs when a HandoffToThird message is received by a tandem or anchor switch which does not support a handoff operation with path minimization. The result is a RETURN ERROR or REJECT response sent back to the requesting switch. Alternatively, no response at all may be received by the requesting switch. When this occurs, the serving switch must send a FacilitiesDirective message back along the call path, past the tandem switch, so that the handoff can occur. However, once again, previously connected trunks along the call path will not be released, and network resources will be wasted.

These scenarios are illustrated in Figs. 1, 2, 3, and 4. A successful sequence of handoff operations in the prior art can be seen in the network signaling and nodal operation diagram of Fig. 1. In this case, a successful handoff back with tandem using the HandoffToThird message and path minimization are shown

within a telecommunications network 15 including a telephone 40, an anchor MSC 60, a tandem1 MSC 70, a serving MSC 90, and a MS 50 are shown. There is an active call connection between the telephone 40 and MS 50, using switches 60, 70, and 90, which are connected by trunks 120 and 130. The telephone 40 (which may be a wireline telephone or another MS) is connected to the switches 60, 70, and 90 by way of a residential line connection or wireless network interface 110, and the MS 50 is connected to the serving MSC using a wireless network interface 140.

If the serving MSC 90 operates to determine that a handoff operation to a nearby candidate MSC, such as the anchor MSC 60, is appropriate, the serving MSC 90 may send a HandoffMeasurementRequest message 150 to the anchor MSC 60. In response, the candidate MSC 60 performs location measurements according to its internal programming algorithms, and returns the results to the serving MSC 90 in the form of a HandoffMeasurementRequest response 160. Based on the response 160 content, the serving MSC 90 determines that the call should be handed off to the anchor MSC 60, which is now also considered the target MSC 60. The anchor MSC 60 will be directed to receive the MS 50 using the handoff back call connection with path minimization operation, and the MS 50 will be moved to the designated channel 107 of the anchor MSC 60. Directing the anchor MSC 60 to receive the MS 50 involves sending a HandoffToThird message 290 from the serving MSC 90 to the tandem1 MSC 70, which in turn directs the tandem1 MSC 70 to perform an intersystem handoff task with path minimization; sending a HandoffToThird message 320 from the tandem1 MSC 70 to the anchor MSC 60, which results in directing the anchor MSC 60 to perform task minimization and verifies that the designated channel 107 of the anchor MSC 60 is

available to support the MS 50; and sending a HandoffToThird response along the call path from the anchor MSC 60 to the serving MSC 90 (steps 330 and 340).

5           Moving the MS 50 to the designated channel 107 of the anchor MSC 60 requires sending a Mobile Handoff Order 190 from the serving MSC 90 to the MS 50 and receiving the MS 50 on the designated channel 107 at arrival step 200.

10           Directing the tandem1 MSC 70 and serving MSC 90 to release the first and second inter-MSC trunks 120 and 130, and marking the first and second inter-MSC trunks 120 and 130 as idle requires sending a FacilitiesRelease message along the call path from the  
15           anchor MSC 60 to the serving MSC 90 (i.e., steps 220 and 230), sending a FacilitiesRelease response 260 along the call path from the serving MSC 90 to the tandem1 MSC 70, and sending a FacilitiesRelease response 270 along the call path from the tandem1 MSC  
20           70 to the anchor MSC 60. At this point, the call path includes only the telephone line or wireless network interface 110, the anchor MSC 60, and the wireless network interface 280 between the telephone 40 and the MS 50. No unused inter-MSC trunks 120, 130 are left  
25           connected, and network resources are conserved.

          Fig. 2 is a network signaling and nodal operation diagram illustrating prior art handoff back operations, wherein the telecommunications network 10 includes a telephone 40, an anchor MSC 60, a tandem1 MSC 70,  
30           tandem2 MSC 80, serving MSC 90, and a MS 50. There is an active call connection between the telephone 40 and MS 50, using a series of switches 100, which are connected by trunks 120, 130, and 135. The telephone 40 (which may be a wireline telephone or another MS) is  
35           connected to the switches by way of a residential line connection or wireless network interface 110 and the MS

50 is connected to the serving MSC using a wireless network interface 140.

5 If the serving MSC 90 operates to determine whether a handoff operation to an adjacent candidate MSC, such as the tandem2 MSC 80, is appropriate, the serving MSC 90 may send a HandoffMeasurementRequest message 150 to the tandem2 MSC 80. In response, the candidate MSC 80 performs location measurements according to its internal programming algorithms, and  
10 returns the results to the serving MSC 90 in the form of a HandoffMeasurementRequest response 160. Based on the response 160 content, the serving MSC 90 determines that the call should be handed off to the tandem2 MSC 80, which is now also considered the target MSC 80.  
15 Further, the serving MSC 90 has determined that the tandem2 MSC 80 is already trunk-connected along the call path.

At this point, a HandoffBack message 163 is sent from the serving MSC 90 to the target MSC 80, which  
20 directs the target MSC 80 to initiate a handoff back task. If a voice channel on the target MSC 80 is available, a HandoffBack response 167 is returned to the serving MSC 90, which allows the handoff operation to proceed.

25 The serving MSC 90, upon receipt of the HandoffBack response 167, sends a Handoff Order message 190 to the served MS 50. This action directs the MS 50 to move to the available voice channel on the target MSC 80. Upon arrival 200 of the MS 50 on the voice  
30 channel of the target MSC 80, a FacilitiesRelease message 202 is sent from the target MSC 80 to the serving MSC 90. This indicates that the handoff operation has been successful and that the facilities used by the serving MSC 90 are no longer needed. The  
35 serving MSC 90, in turn, sends a FacilitiesRelease response 204 to the target MSC 80, releasing the trunk

connection 135 and marking the inter-MSC trunk 135 as idle. The target MSC 80, in turn, marks the inter-MSC trunk 135 as idle and the handoff back process is complete. The resulting call connection between the telephone 40 and the MS 50 comprises the series of switches 100 connected by trunks 120 and 130. The telephone 40 is connected to the switches 100 by way of line connection or wireless interface 110, and the MS 50 is connected to the new serving MSC 80 using the wireless network interface 137.

The scenario 20 just described, is a classic prior art handoff back operation from a serving switch 100 to a tandem switch 100, where the tandem switch 100 is trunk-connected to the serving switch 100 along the call path. In this case, no network resources are wasted, and the ANSI-41 protocol operation functions in an efficient manner.

Turning now to scenario 30 of Fig. 3, the prior art handoff back operation to a tandem switch 100 (i.e., tandem1 MSC 70), which is in the call path, but is not trunk-connected to the serving MSC 90 and path minimization is not supported, is illustrated. In this case, as will be described, a handoff back operation results in wasted network resources.

As noted above, an active call connection between the telephone 40 and the Mobile Station 50 exists, making use of trunk connections 120, 130, and 135. A HandoffMeasurementRequest message 150 is sent from the serving MSC 90 to the tandem1 MSC 70. The HandoffMeasurementRequest response 160 is returned to the serving MSC 90, where it is determined that a handoff back operation from the serving MSC 90 to the tandem1 MSC 70 is desirable.



5 A FacilitiesDirective message 165 is then sent  
from the serving MSC 90 to the tandem1 MSC 70, which  
results in a FacilitiesDirective response 169 from the  
tandem1 MSC 70 to the serving MSC 90. The Handoff  
Order 190 is sent to MS 50, and the MS 50 arrives 200  
on the available channel of the tandem1 MSC 70. The  
tandem1 MSC 70 sends a Mobile Station On Channel  
message 206 to the initiator of the handoff back task  
(i.e., the serving MSC 90), informing the serving MSC  
10 90 that the tandem1 MSC 70 has completed the handoff  
back task. Unfortunately, at this point, all of the  
trunks 120, 130, and 135 are still connected.  
Moreover, a new trunk 138, has also been connected  
between the tandem1 MSC 70 and the serving MSC 90. The  
15 resulting call connection between the telephone 40 and  
the MS 50 comprises the series of switches 100  
connected by trunks 120, 130, 135, and 138. The  
telephone 40 is connected to the switches 100 by way of  
line connection or wireless interface 110, and the MS  
20 50 is connected to the new serving MSC 70 using the  
wireless network interface 139. Network resources are  
wasted in this case, because the most efficient  
connection between the telephone 40 and the MS 50  
should require only the trunk connection 120, such that  
25 the network resources tandem2 MSC 80, serving MSC 90,  
and trunks 130, 135, and 138 can be released.

Referring now to Fig. 4, scenario 35 illustrates  
what can happen in prior art communications when a  
HandoffToThird message is sent to a switch which is  
30 incapable of accepting the message for execution. The  
same result may occur if no response is received to the  
message due to congestion within the network 15, or for  
other reasons recognized by those skilled in the art.

5 In this case, a HandoffMeasurementRequest message  
150 is sent from the serving MSC 90 to the tandem1 MSC  
70 (the desired target switch 100), which elicits a  
HandoffMeasurementRequest response 160 from the tandem1  
MSC 70 to the serving MSC 90. The serving MSC 90, in  
turn, sends a HandoffToThird message 290 to the tandem2  
MSC 80, which is incapable of processing the message  
290. As noted above, there may be no response because  
the tandem2 MSC 80 does not support the HandoffToThird  
10 command, or possibly, because the network 15 is  
congested. In any event, an error 300 occurs, and the  
serving MSC 90 receives a response such as RETURN  
ERROR, REJECT, or NO RESPONSE (i.e., no response at all  
is received).

15 Since the tandem2 MSC 80 is incapable of  
supporting a handoff operation with path minimization  
(as evidenced by the error message), a  
FacilitiesDirective message 165 is instead sent from  
the serving MSC 90 to the tandem1 MSC 70, or target MSC  
20 70. Once the tandem1 MSC 70 verifies that a designated  
channel is available for use by the MS 50, a  
FacilitiesDirective response 169 is sent from the  
tandem1 MSC 70 to the serving MSC 90. This results in  
a Handoff Order message 190 being sent from the serving  
25 MSC 90 to the MS 50 directing movement of the MS 50  
onto the designated channel at the tandem 1 MSC 70.  
After arrival 200 of the MS 50 on the designated  
channel at the tandem1 MSC 70, the tandem1 MSC 70 will  
send a Mobile Station On Channel message 206 to the  
30 serving MSC 90. Once again, the problem of excessive  
trunks remaining in use exists. In this case, the  
original trunks 120, 130, and 135 are still connected,  
with the additional trunk 138 also having been  
established as a result of the handoff operation.  
35 Network resources in this situation are wasted in this  
case because the most efficient connection between the

telephone 40 and the MS 50 should require only the trunk connection 120, such that the network resources tandem2 MSC 80, serving MSC 90, and trunks 130, 135, and 138 can be released.

5           Therefore, what is needed is a method to support a handoff back call connection operation within a telecommunications network, including multiple, connected switches, that enables the release of unused trunks along the call path when the target switch is  
10           already active within the call path, and not directly connected to the serving switch. Such a method should be usable within the current ANSI-41 D Standard, and also be backward-compatible with previous versions of the standard. Such a method should require no changes  
15           in currently-available network switch hardware.

#### SUMMARY OF THE INVENTION

          The method of the present invention operates to enable handoff back operations within a telecommunications network during two different call  
20           connection scenarios. First, when path minimization is not possible, and the handoff occurs between a serving switch and a target switch, wherein the target switch is already connected as an anchor or a tandem within the call path, and not directly trunk-connected to the  
25           serving switch. Second, where the call path is the same as in the first scenario, and path minimization may be possible, but it is determined that one of the switches in the call path does not support path minimization operations. In each case, the target MSC  
30           is a switch in the call path that has no direct trunk connection to the switch currently serving the MS, which is the circumstance leading to inefficiencies and wasted resources using current ANSI-41D handoff back operations.

When path minimization is not supported among the switches of the active call path, the method supporting mobile station handoff back call connection operations within a telecommunications network includes the steps

5 of determining that a handoff back call connection operation to a target MSC should occur, verifying that a designated channel on the target MSC is available to support the Mobile Station, moving the Mobile Station to the designated channel of the target MSC, directing

10 the switches along the call path that are no longer needed to release any unnecessary inter-MSC trunks, and marking the released inter-MSC trunks as idle.

If path minimization operations may be possible, but are found to not be supported by at least one

15 switch within the call path, the method supporting mobile station handoff back call connection operations within a telecommunications network comprises the steps of determining that a handoff back call connection operation to a target MSC should occur, determining

20 that the target MSC will not support path minimization operations, verifying that a designated channel on the target MSC is available to support the Mobile Station, moving the Mobile Station to the designated channel of the target MSC, directing the switches along the call

25 path that are no longer needed to release any unnecessary inter-MSC trunks, and marking the released inter-MSC trunks as idle. The step of determining that the target MSC (or any tandem along the call path) will not support a path minimization operation may be

30 accomplished by sending a HandoffToThird message from the serving MSC to the MSC which will not support path minimization (i.e., a non-capable MSC), which directs the non-capable MSC to perform path minimization, and receiving a response from the non-capable MSC at the

35 serving MSC, which is a RETURN ERROR, REJECT, or NO RESPONSE (meaning that no response at all is received

within the timeout period of the service MSC or switch message reception timer).

#### BRIEF DESCRIPTION OF THE DRAWINGS

5 Fig. 1 (previously described) is a network signaling and nodal operation diagram illustrating prior art handoff operations as used in a network that supports path minimization;

10 Fig. 2 (previously described) is a network signaling and nodal operation diagram illustrating prior art handoff back operations;

Fig. 3 (previously described) is a network signaling and nodal operation diagram illustrating prior art handoff back operations without path minimization;

15 Fig. 4 (previously described) is a network signaling and nodal operation diagram illustrating prior art handoff back operations with path minimization;

20 Fig. 5 is a network signaling and nodal operation diagram illustrating the method of the present invention for handoff back operations where no path minimization is possible; and

25 Fig. 6 is a network signaling and nodal operation diagram illustrating the method of the present invention where path minimization may be possible, but fails.

#### DETAILED DESCRIPTION OF PRESENTLY

##### PREFERRED EXEMPLARY EMBODIMENTS

30 The method of the present invention is adaptable to at least two different inter-system (inter-exchange) handoff scenarios. The first is a handoff back with tandem via the FacilitiesDirective message, where path minimization is not supported. The second is a handoff back with tandem via the FacilitiesDirective message when HandoffToThird messaging with tandem and path  
35 minimization is attempted, but fails.

Turning now to Fig. 5, the network signaling and nodal operation diagram illustrating the first method of the present invention can be seen. Generally, there is a telecommunications network 15 comprising several switches 105 connected along a call path between a telephone 40 and a Mobile Station 50. For example, the switches 105 may comprise an anchor MSC 65 connected to a tandem1 MSC 75 by a trunk 120, which is, in turn, connected to a serving MSC 95 by a trunk 130. The telephone 40 (which may be a wireline phone, mobile phone, or other telephonic communication device) is connected by a telephone line 110 (or wireless network interface, etc. as appropriate for the type of device 40) to the anchor MSC 65, and the Mobile Station 50 is connected by a wireless network interface 140 to the serving MSC 95. It should be noted that in every instance where a HandoffBackMessage, a HandoffMeasurementRequest message, a HandoffToThird message, or a FacilitiesDirective message are used, the HandoffBack2, HandoffMeasurementRequest2 message, HandoffToThird2 message, and FacilitiesDirective2 messages may be substituted. This accommodates data service transmissions, which are only supported by the HandoffBack2, HandoffMeasurementRequest2, HandoffToThird2, and FacilitiesDirective2 messages.

The first embodiment of the invention involves a method supporting a handoff back call connection operation within a telecommunications network via the FacilitiesDirective process when more than two switches are involved, and the handoff is to a switch (anchor or tandem MSC) that has no direct trunk connection to the currently-serving switch, but path minimization is not supported. In this exemplary case, the anchor MSC performs the handoff back function.

The telecommunications network 15 includes a MS 50 served by a Serving Mobile Switching Center (SMSC) 95, using a wireless network interface 140, connected along the call path to a tandem MSC (TMSC) 75 and an anchor MSC 65. The anchor MSC 65 is connected to the TMSC 75 by a first inter-MSC trunk 120, and the TMSC 75 is connected to the SMSC 95 by a second inter-MSC trunk 130. The anchor MSC 65 includes a designated available channel 107. The handoff back call connection operation occurs from the SMSC 95 to a switch without a direct trunk connection to the serving SMSC 95 (e.g., the anchor MSC 65).

The method includes the step of determining that a handoff back call connection operation to a target MSC should occur. The target MSC is the anchor MSC 65 in this case. The next step is verifying that the designated channel 107 of the anchor MSC 65 is available to support the MS 50. Next, the method involves establishing an inter-MSC trunk 185 between the anchor MSC 65 and the serving MSC 95, and moving the MS 50 to the designated channel 107 of the anchor MSC 65. The method includes the step of directing the tandem1 MSC 75 and the serving MSC 95 to release the first, second, and third inter-MSC trunks 120, 130, and 185, respectively. Finally, the method may include the step of marking the first, second, and third inter-MSC trunks 120, 130, and 185 as idle.

The step of determining that the handoff back action to the target MSC (i.e., the anchor MSC 65) should occur may include the steps of sending a HandoffMeasurementRequest message 150 from the serving MSC 95 to the anchor MSC 65, which is followed by the step of sending a HandoffMeasurementRequest response 160 from the anchor MSC 65 to the serving MSC 95. The serving MSC 95 determines the target for a handoff based on measurements report by the anchor MSC 65. The

step of verifying that the designated channel 107 of the anchor MSC 65 is available to support MS 50 and establishing an inter-MSC trunk 185 between the anchor MSC 65 and the serving MSC 95 may include the step of sending a FacilitiesDirective message 170 along the call path from the serving MSC 95 to the anchor MSC 65 to direct the anchor MSC 65 to initiate an intersystem handoff task, and the step of sending a FacilitiesDirective response 180 from the anchor MSC 65 to the service MSC 95 to verify the designated channel 107 is available to support the MS 50 and establish the inter-MSC trunk 185 between the anchor MSC 65 and the serving MSC 95. The step of moving the MS 50 to the designated channel 107 of the anchor MSC 65 may include the steps of sending a Mobile Handoff Order message 190 from the serving MSC 95 to the MS 50, receiving the MS 50 on the designated channel 107 at the arrival step 200, and sending a Mobile Station On Channel message 210 from the anchor MSC 65 to the serving MSC 95. Finally, the step of having the target/anchor MSC 65 direct the tandem1 MSC 75 and the serving MSC 95 to release the first, second, and third inter-MSC trunks 120, 130, and 185 may include the steps of sending a FacilitiesRelease message along the call path from the anchor MSC 65 to the serving MSC 95 (steps 220 and 230), sending a FacilitiesRelease message 240 along the call path from the serving MSC 95 to the anchor MSC 65, sending a FacilitiesRelease response 250 along the call path from the anchor MSC 65 to the serving MSC 95, and sending a FacilitiesRelease response along the call path from the serving MSC 95 to the anchor MSC 65 (steps 260 and 270).

At this point, the inter-MSC trunks 120, 130, and 185 have been released. The remaining connections within the network include the telephone line 110 and a wireless network interface 280. No unnecessary



inter-MSC trunks remain connected along the call path between the telephone 40 and the MS 50.

Turning now to Fig. 6, the second embodiment of the method of the present invention can be seen. In this case, a method of supporting a handoff back call connection operation within a telecommunications network using the FacilitiesDirective message with path minimization (and message support failure) is demonstrated. In this instance, the initial network includes a telephone 40 (which may be a mobile phone or other telecommunications device) connected to an anchor MSC 65 using a telephone line 110 (or wireless network interface, etc. as appropriate to the telephonic device 40), and an MS 50 served by a serving MSC 95, over a wireless network interface 140, connected along the call path to a tandem2 MSC (TMSC2) 85, a tandem1 MSC (TMSC1) 75 and an anchor MSC 65. The anchor MSC 65 is connected to the TMSC1 75 by a first inter-MSC trunk 120, the TMSC1 75 is connected to the TMSC2 85 by a second inter-MSC trunk 130, and the TMSC2 85 is connected to the SMSC 95 by a third inter-MSC trunk 135. The TMSC1 75 includes a designated channel 107. However, the method in this case comprises the steps of determining that a handoff back call connection operation to a target MSC should occur, wherein the target MSC is the switch without a direct trunk connection to the serving MSC 95, such as tandem1 MSC 75, and determining that the tandem2 MSC 85 (in this exemplary case) will not support a path minimization operation. The next steps involve verifying that the designated channel 107 of the tandem1 MSC 75 is available to support the MS 50, establishing a fourth inter-MSC trunk 185 between the tandem1 MSC 75 and the serving MSC 95, moving the MS 50 to the designated channel 107 of the tandem1 MSC 75, and then directing the tandem2 MSC 85 and the serving MSC 95 to release

the second, third, and fourth inter-MSC trunks 130, 135 and 185. Finally, the method may include the step of marking the second, third, and fourth inter-MSC trunks, 130, 135, and 185 as idle.

5           The step of determining that a handoff back call connection operation to the target MSC should occur may include the steps of sending a HandoffMeasurementRequest message 150 from the serving MSC 95 to the tandem1 MSC 75, and sending a  
10       HandoffMeasurementRequest response 160 from the tandem1 MSC 75 to the serving MSC 95. The step of determining that the tandem2 MSC 85 will not support a path minimization operation may include the steps of sending a HandoffToThird message 290 from the serving MSC 95 to  
15       the tandem2 MSC 85, directing the tandem2 MSC 85 to perform an intersystem handoff task with path minimization, and receiving a response 300 from the tandem2 MSC 85 at the serving MSC 95, such as RETURN ERROR, REJECT, or NO RESPONSE (i.e., no response is  
20       received at the serving MSC 95 within the timeout period of the switch 95 message reception timer 197). The step of verifying that the designated channel 107 of the tandem1 MSC 75 is available to support the MS 50 and establishing an inter-MSC trunk connection 185  
25       between the tandem1 MSC 75 and the serving MSC 95 may include the steps of sending a FacilitiesDirective message 170 from the serving MSC 95 to the tandem1 MSC 75 to direct the tandem1 MSC 75 to initiate an intersystem handoff task, and the step of sending a  
30       FacilitiesDirective response 180 from the tandem1 MSC 75 to the serving MSC 95 to verify the designated channel 107 is available to support the MS 50 and establish the inter-MSC trunk 185 between the tandem1 MSC 75 and the serving MSC 95. The step of moving the  
35       MS 50 to the designated channel 107 of the anchor MSC 65 includes the steps of sending a Mobile Handoff Order

5 message 190 from the serving MSC 95 to the MS 50, receiving the MS 50 on the designated channel 107 at arrival step 200, and sending a Mobile Station On Channel message 210 from the tandem1 MSC 75 to the  
10 serving MSC 95. Finally, the step of directing the tandem2 MSC 85 and the serving MSC 95 to release the second, third, and fourth inter-MSC trunks 130, 135 and 185 includes the steps of sending a FacilitiesRelease message along the call path from the tandem1 MSC 75 to  
15 the serving MSC 95 (steps 220 and 230) via the tandem2 MSC 85, sending a FacilitiesRelease message 240 along the call path from the serving MSC 95 to the tandem1 MSC 75, sending a FacilitiesRelease response 250 along the call path from the tandem1 MSC 75 to the serving  
20 MSC 95, and sending a FacilitiesRelease response along the call path from the serving MSC 95 to the tandem1 MSC 75 (steps 260 and 270) via the tandem2 MSC 85. At this point, the call path includes only the telephone line 110, the anchor MSC 65 connected to the TMSC1 75 by a trunk 120, and the wireless network interface 280 between the telephone 40 and the MS 50. No unnecessary inter-MSC trunks 130, 135, and 185 are left connected, and network resources are conserved.

25 Although the invention has been described with reference to specific embodiments, this description is not meant to be construed in a limited sense. The various modifications of the disclosed embodiments, as well as alternative embodiments of the invention, will become apparent to persons skilled in the art upon  
30 reference to the description of the invention. It is, therefore, contemplated that the appended claims will cover such modifications that fall within the scope of the invention, or their equivalents.

## CLAIMS

What is claimed is:

1. A method supporting a handoff back call connection operation within a telecommunications network including a Mobile Station (MS) served by a Serving Mobile Switching Center (SMSC) connected along  
5 a call path to a Tandem MSC (TMSC) and a Mobile Switching Center (MSC), wherein the MSC is connected to the TMSC by a first inter-MSC trunk and the TMSC is connected to the SMSC by a second inter-MSC trunk, wherein the MSC includes a designated channel, and  
10 wherein the handoff back call connection operation occurs from the SMSC to the MSC, comprising the steps of:

determining that the handoff back call connection operation to a Target MSC should occur, wherein the  
15 Target MSC is the MSC;

verifying that the designated channel of the MSC is available to support the MS and establishing a third inter-MSC trunk between the MSC and the SMSC;

20 moving the MS to the designated channel of the MSC; and

sending a message along the call path from the MSC to the TMSC and the SMSC directing the TMSC and the SMSC to release the first, second, and third inter-MSC trunks.

2. The method of Claim 1, wherein the step of determining that a handoff back action to the Target MSC should occur includes the steps of:

5 sending a HandoffMeasurementRequest message from the SMSC to the MSC; and

sending a HandoffMeasurementRequest response from the MSC to the SMSC.

3. The method of Claim 1, wherein the step of verifying that the designated channel of the MSC is available to support the MS and establishing the third inter-MSC trunk between the MSC and the SMSC includes the steps of:

5        sending a FacilitiesDirective message from the SMSC to the MSC to direct the MSC to initiate an intersystem handoff task; and  
10        sending a FacilitiesDirective response from the MSC to the SMSC to verify the designated channel is available to support the MS and establish the third inter-MSC trunk between the MSC and the SMSC.

4. The method of Claim 1, wherein the step of moving the MS to the designated channel of the MSC includes the steps of:

5        sending a MobileHandoffOrder message from the SMSC to the MS;  
      receiving the MS on the designated channel; and  
      sending a Mobile Station On Channel message from the MSC to the SMSC.

5. The method of Claim 1, wherein the step of directing the TMSC and SMSC to release the first, second, and third inter-MSC trunks includes the steps of:

5        sending a FacilitiesRelease message along the call path from the MSC to the TMSC;  
      sending a FacilitiesRelease message along the call path from the TMSC to the SMSC;  
10        sending a FacilitiesRelease message along the call path from the SMSC to the MSC;  
      sending a FacilitiesRelease response along the call path from the MSC to the SMSC;  
      sending a FacilitiesRelease response along the call path from the SMSC to the TMSC; and

15            sending a FacilitiesRelease response along the  
call path from the TMSC to the MSC.

5            6. A method supporting a handoff back call  
connection operation within a telecommunications  
network including a Mobile Station (MS) served by a  
Serving Mobile Switching Center (SMSC) connected along  
a call path to a Tandem MSC (TMSC) and a Mobile  
Switching Center (MSC), wherein the MSC is connected to  
the TMSC by a first inter-MSC trunk and the TMSC is  
connected to the SMSC by a second inter-MSC trunk,  
wherein the MSC includes a designated channel, and  
10           wherein the handoff back call connection operation  
occurs from the Serving MSC to the Anchor MSC,  
comprising the steps of:

15           determining that the handoff back call connection  
operation to a Target MSC should occur, wherein the  
Target MSC is the MSC;

             determining that the MSC will not support a path  
minimization operation;

20           verifying that the designated channel of the MSC  
is available to support the MS and establishing a third  
inter-MSC trunk between the MSC and the SMSC;

             moving the MS to the designated channel of the  
MSC; and

             directing the TMSC and SMSC to release the first,  
second, and third inter-MSC trunks.

7. The method of Claim 6, wherein the step of  
determining that a handoff back call connection  
operation to the Target MSC should occur includes the  
steps of:

5            sending a Handoff Measurement Request message from  
the SMSC to the MSC; and

             sending a Handoff Measurement Request response  
from the MSC to the SMSC.

8. The method of Claim 6, wherein the step of determining that the MSC will not support a path minimization operation includes the steps of:

5 sending a HandoffToThird message from the SMSC to the TMSC directing the TMSC to perform an intersystem handoff task with path minimization; and

receiving a response from the MSC at the SMSC selected from the group consisting of: NO RESPONSE, RETURN ERROR, or REJECT.

9. The method of Claim 6, wherein the step of verifying that the designated channel of the MSC is available to support the MS and establishing a third inter-MSC trunk between the MSC and the SMSC includes the steps of:

5 sending a Facilities Directive message from the SMSC to the MSC to direct the MSC to initiate an intersystem handoff task; and

10 sending a Facilities Directive response from the MSC to the SMSC to verify the designated channel is available to support the MS and establish the third inter-MSC trunk between the MSC and the SMSC.

10. The method of Claim 6, wherein the step of moving the MS to the designated channel of the MSC includes the steps of:

5 sending a Mobile Handoff Order message from the SMSC to the MS;

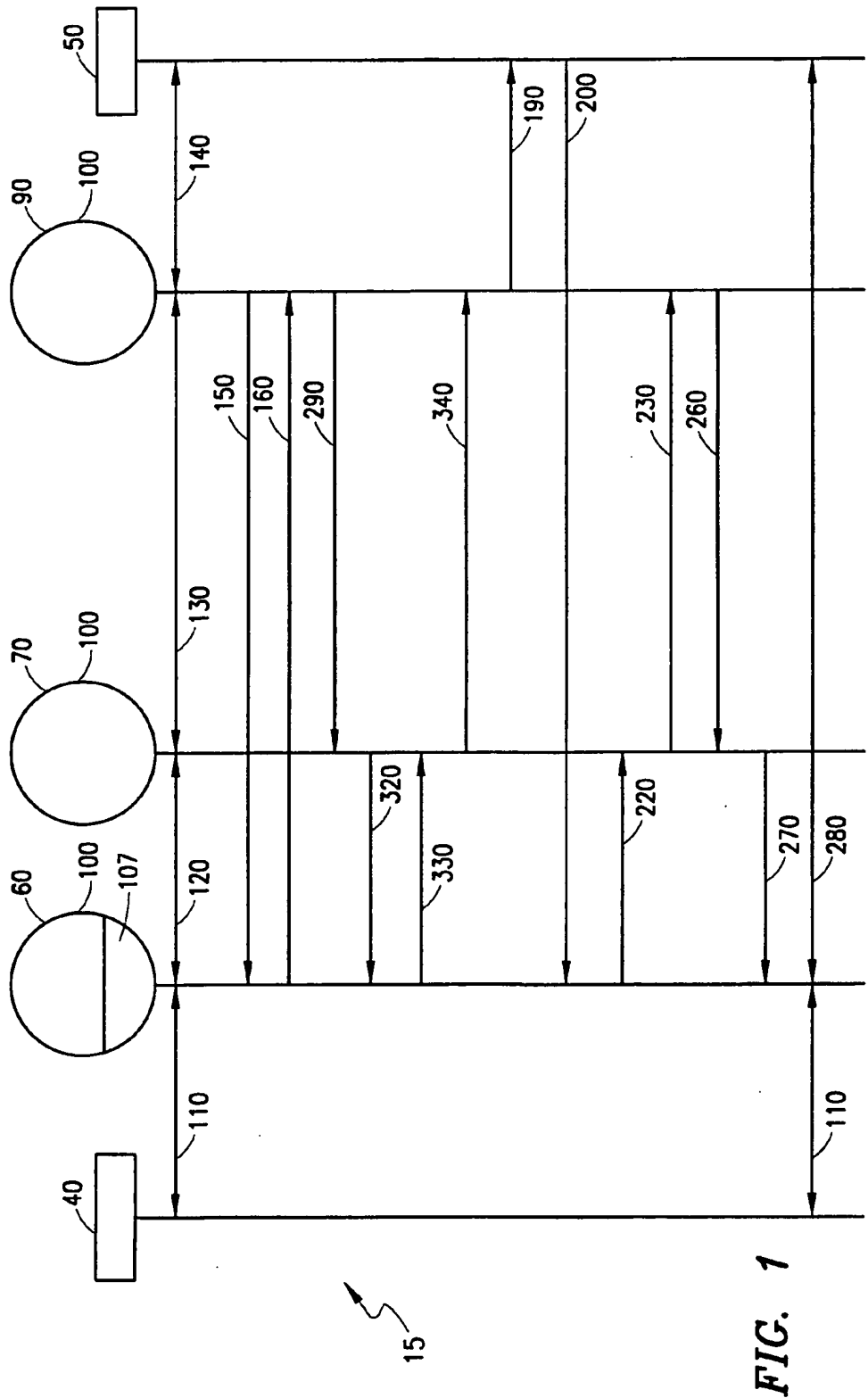
receiving the MS on the designated channel; and

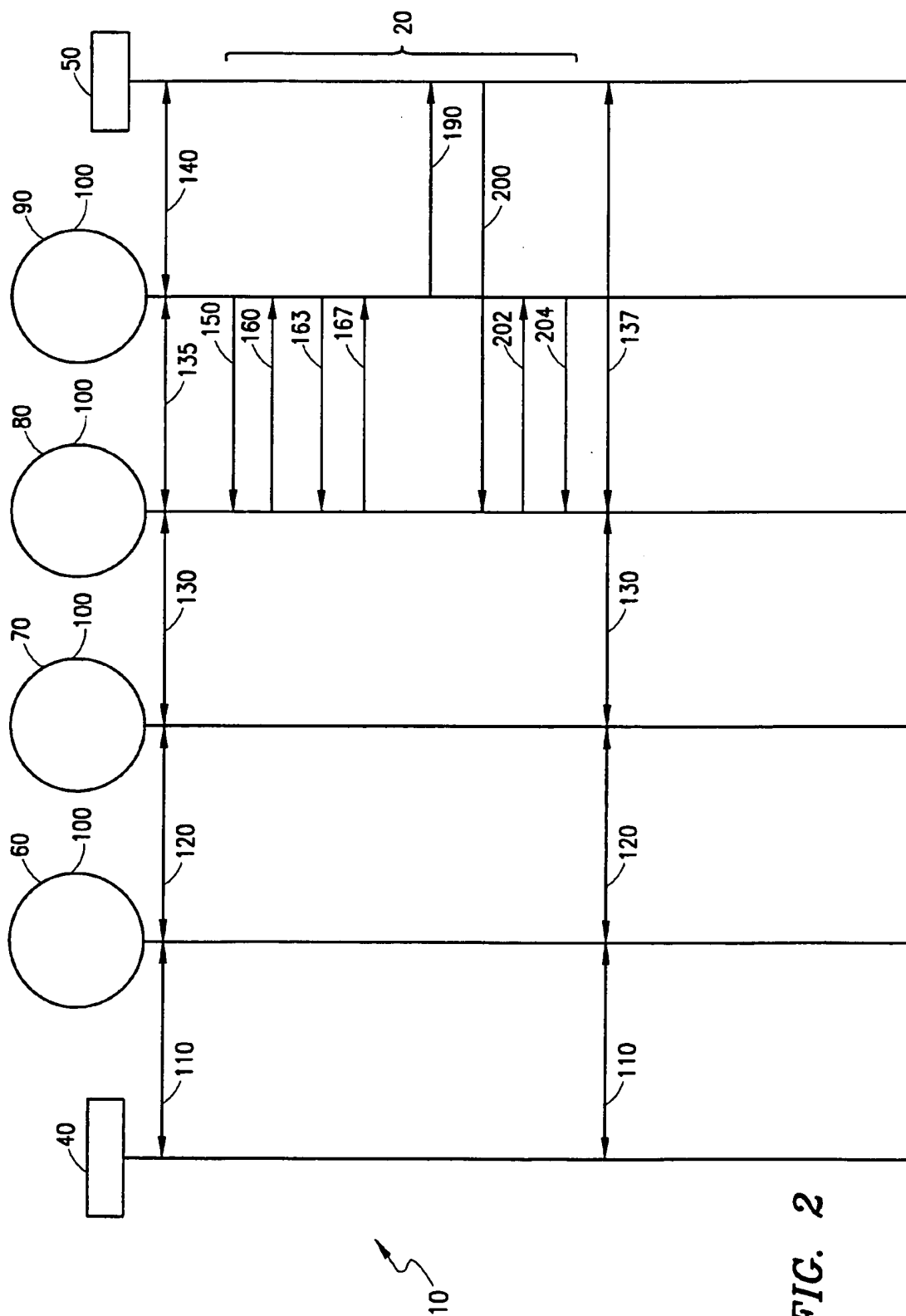
sending a Mobile Station On Channel message from the MSC to the SMSC.

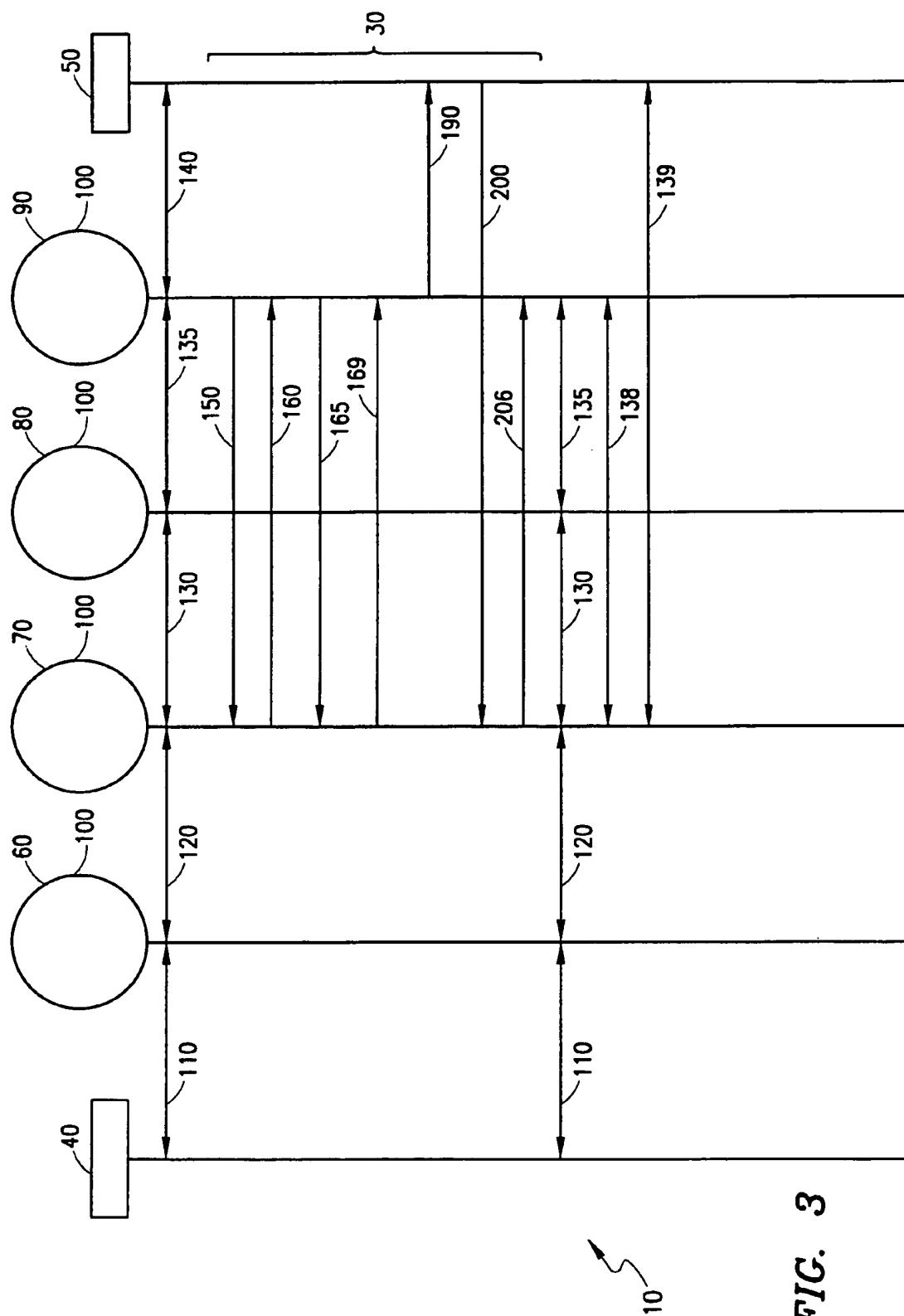
11. The method of Claim 6, wherein the step of directing the TMSC and SMSC to release the first, second, and third inter-MSC trunks includes the steps of:

- 5            sending a Facilities Release message along the call path from the MSC to the TMSC;
- sending a Facilities Release message along the call path from the TMSC to the SMSC;
- sending a FacilitiesRelease message along the call
- 10          path from the SMSC to the MSC;
- sending a FacilitiesRelease response along the call path from the MSC to the SMSC;
- sending a Facilities Release response along the call path from the SMSC to the TMSC; and
- 15          sending a Facilities Release response along the call path from the TMSC to the MSC.

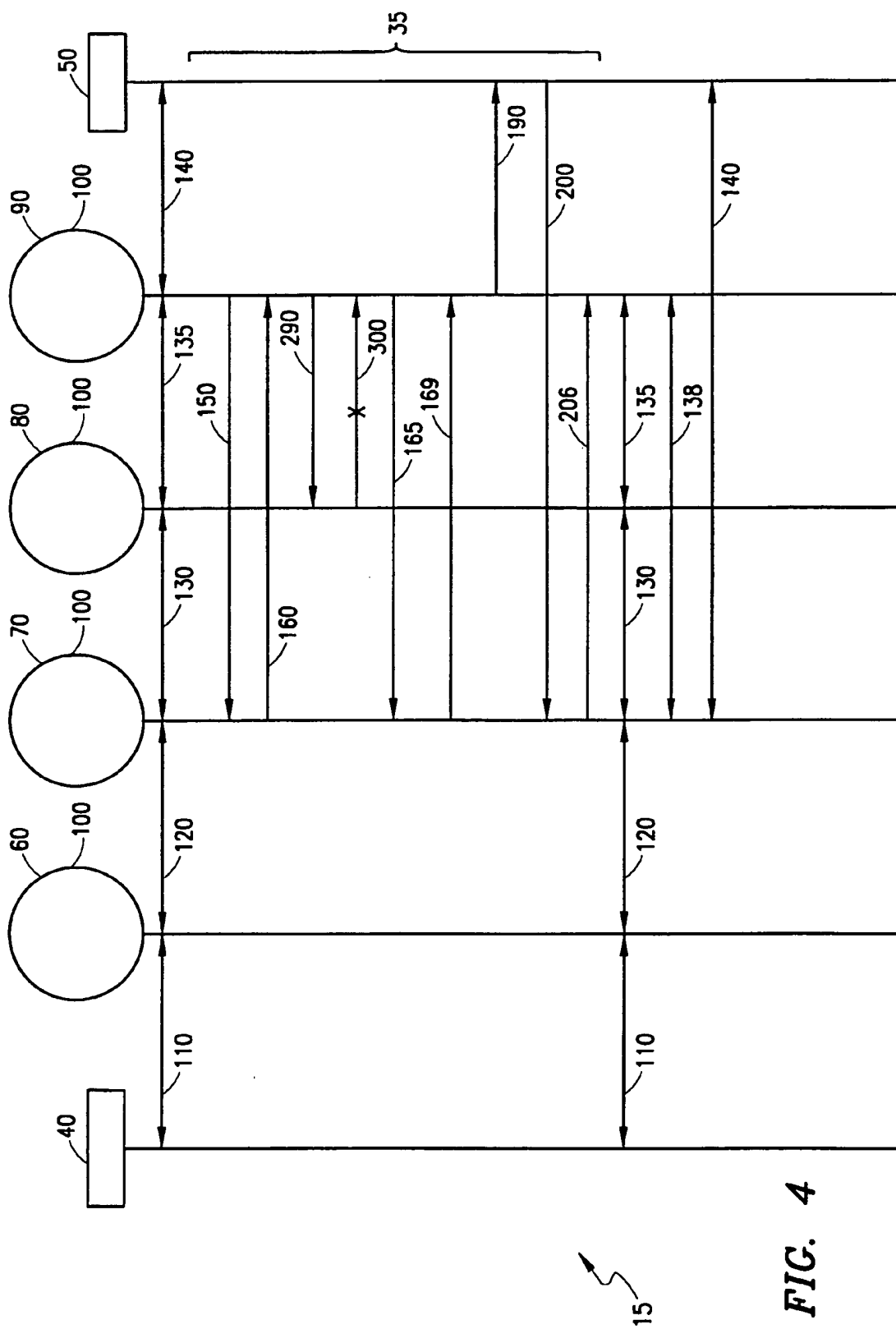








**FIG. 3**



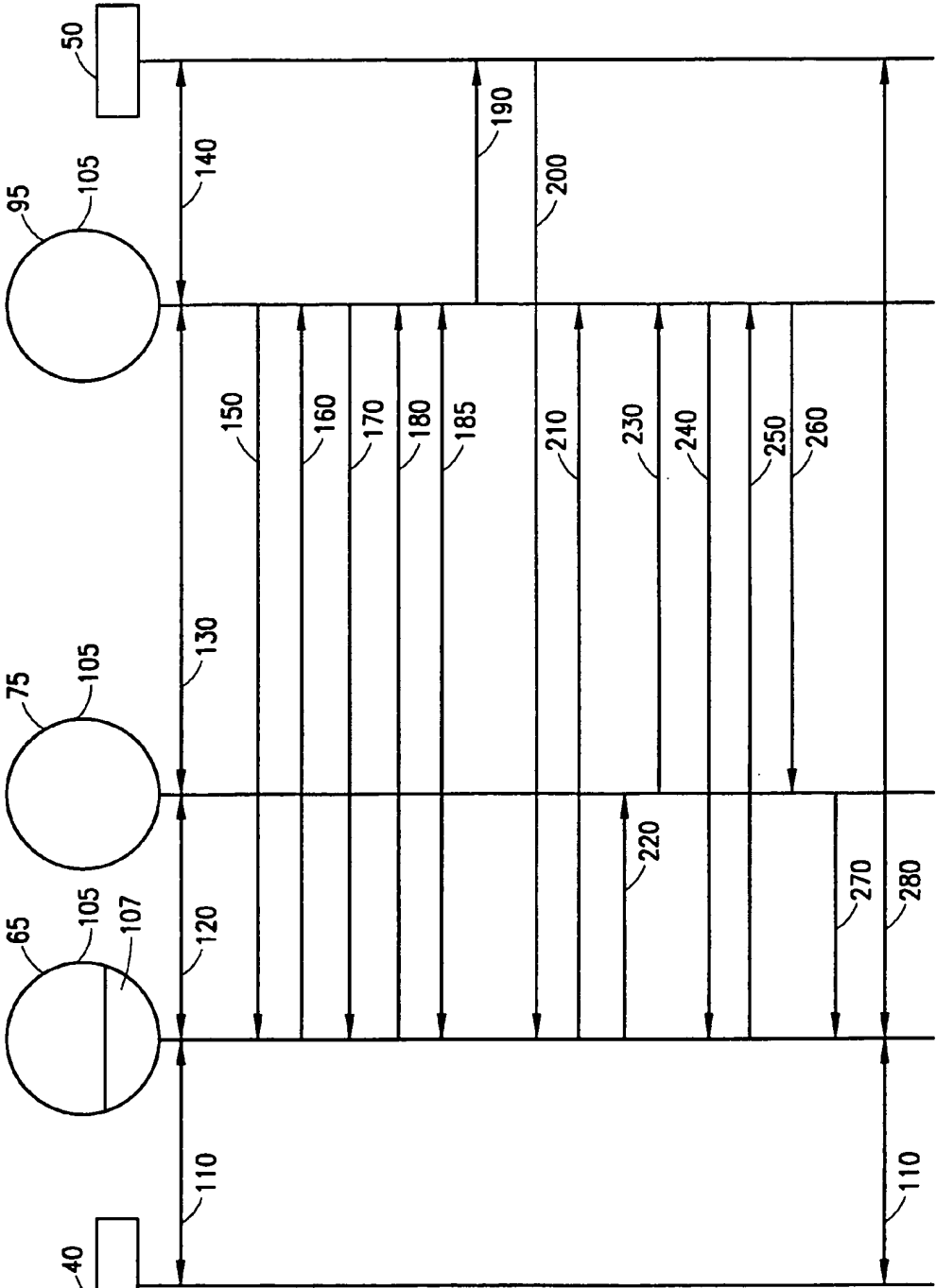


FIG. 5

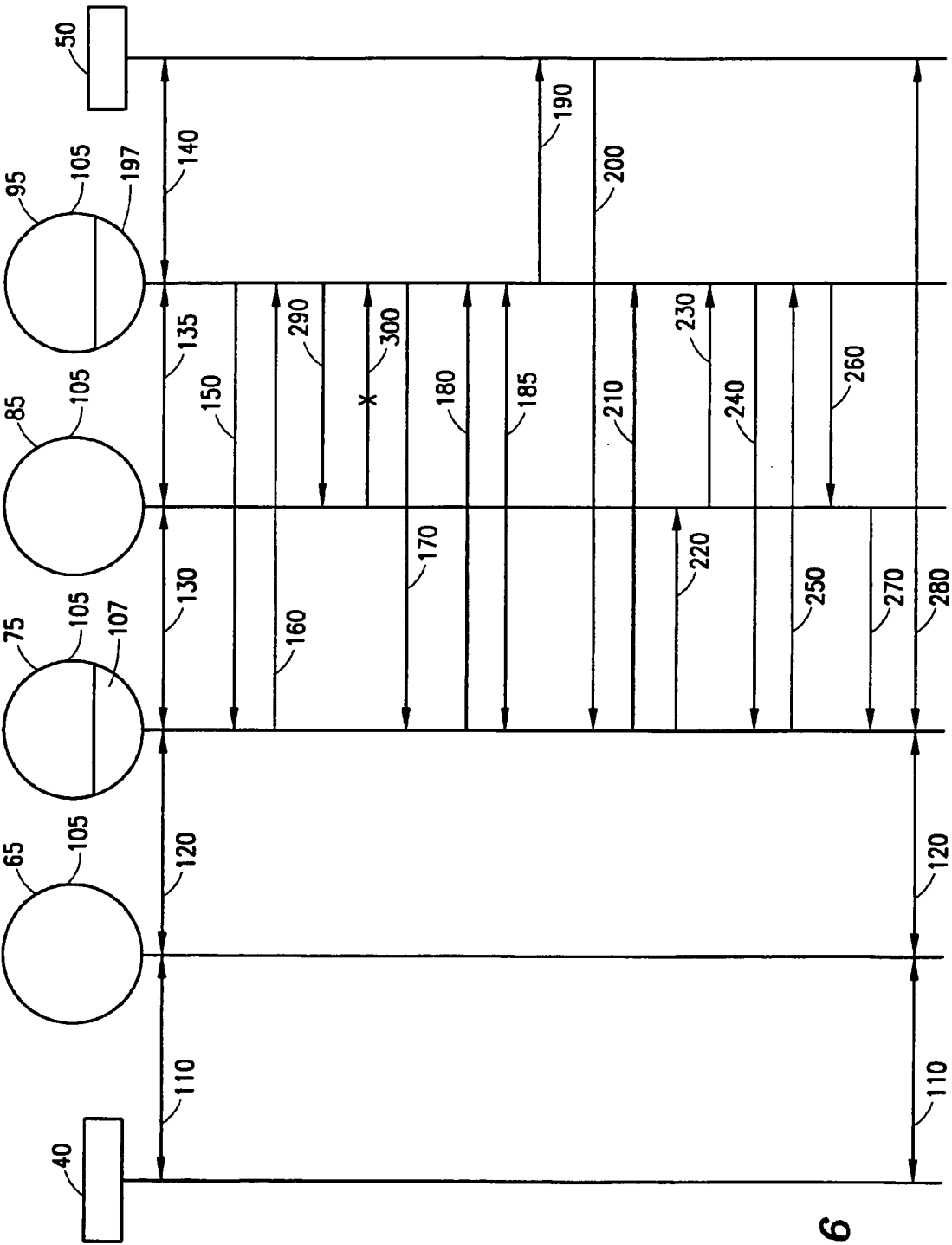


FIG. 6

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/00692

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/38

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 9810596 A2 (TELEFONAKTIEBOLAGET LM ERICSSON), 12 March 1998 (12.03.98), page 3, line 2 - line 17; page 17, line 23 - page 22, line 26, figures 3,4, claims 1-25, abstract --	1-11
Y	WO 9806226 A2 (TELEFONAKTIEBOLAGET LM ERICSSON), 12 February 1998 (12.02.98), page 4, line 27 - page 5, line 26; page 33, line 4 - page 35, line 6, figures 5,6,7, claims 1-21, abstract --	1-11
Y	US 5444773 A (PAUL HIRSOHN ET AL), 22 August 1995 (22.08.95), column 2, line 65 - column 4, line 28, figures 3B,4C, claims 1-19, abstract --	1-11

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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"&amp;" document member of the same patent family

Date of the actual completion of the international search

7 August 2000

Date of mailing of the international search report

04.09.2000

Name and mailing address of the International Searching Authority  
European Patent Office P.B. 5818 Patentlaan 2  
NL-2280 HV Rijswijk  
Tel: (+31-70) 340-2040, Tx 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

KLAS ARVIDSSON/ELY

Telephone No.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/00692

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4398063 A (RONALD J. HASS ET AL), 9 August 1983 (09.08.83), column 2, line 1 - line 30; column 7, line 65 - column 10, line 58, figures 1,5-12, claims 1-9, abstract  --	1-11
Y	US 5018187 A (JOHN A. MARINHO ET AL), 21 May 1991 (21.05.91), column 2, line 22 - line 42; column 4, line 53 - column 6, line 27, figures 10,11, claims 1-9, abstract  -- -----	1-11



**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

02/12/99

International application No.

PCT/SE 00/00692

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				EP	0632667 A	04/01/95
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US	4398063	A	09/08/83	NONE		
US	5018187	A	21/05/91	NONE		